

## CHAPTER XVIII.

Division of igneous agents into the volcano and the earthquake—Distinct regions of subterranean disturbance—Region of the Andes—System of volcanos extending from the Aleutian isles to the Moluccas—Polynesian archipelago—Volcanic region extending from the Caspian Sea to the Azores—Former connexion of the Caspian with Lake Aral and the Sea of Azof—Low steppes skirting these seas—Tradition of Deluges on the shores of the Bosphorus, Hellespont, and the Grecian archipelago—Periodical alternation of earthquakes in Syria and Southern Italy—Western limits of the European region—Earthquakes rarer and more feeble in proportion as we recede from the centres of volcanic action—Extinct volcanos not to be included in lines of active vents.

WE have hitherto considered the changes wrought, since the times of history and tradition, by the continued action of aqueous causes on the earth's surface; and we have next to examine those resulting from igneous agency. As the rivers and springs on the land, and the tides and currents in the sea, have, with some slight modifications, been fixed and constant to certain localities from the earliest periods of which we have any records, so the volcano and the earthquake have, with few exceptions, continued, during the same lapse of time, to disturb the same regions. But as there are signs, on almost every part of our continent, of great power having been exerted by running water on the surface of the land, and by tides and currents on cliffs bordering the sea, where, in modern times, no rivers have excavated, and no tidal currents undermined—so we find signs of volcanic vents and violent subterranean movements in places where the action of fire has long been dormant. We can explain why the intensity of the force of aqueous causes should be developed in succession in different districts. Currents, for example, and tides, cannot destroy our coasts, shape out or silt up estuaries, break through isthmuses, and annihilate islands, form shoals in one place and remove them from another, without the direction and position of their destroying and transporting power becoming transferred to new localities. Neither can

the relative levels of the earth's crust, above and beneath the waters, vary from time to time, as they are admitted to have varied at former periods, and as we shall demonstrate that they still do, without the continents being, in the course of ages, modified, and even entirely altered, in their external configuration. Such events must clearly be accompanied by a complete change in the volume, velocity, and direction of the streams and land floods to which certain regions give passage. That we should find, therefore, cliffs where the sea once committed ravages, and from which it has now retired—estuaries where high tides once rose, but which are now dried up—valleys hollowed out by water, where no streams now flow;—all these and similar phenomena are the necessary consequences of physical causes now in operation; and we may affirm that, if there be no instability in the laws of Nature, similar fluctuations must recur again and again in time to come.

But however natural it may be that the force of running water in numerous valleys, and of tides and currents in many tracts of the sea, should now be *spent*, it is by no means so easy to explain why the violence of the earthquake and the fire of the volcano should also have become locally extinct, at successive periods. We can look back to the time when the marine strata, whereon the great mass of Etna rests, had no existence; and that time is extremely modern in the earth's history. This alone affords ground for anticipating that the eruptions of Etna will one day cease.

Nec quæ sulfureis ardet fornacibus Ætna  
Ignea semper erit, *neque enim fuit igneu semper,*

are the memorable words which are put into the mouth of Pythagoras by the Roman poet, and they are followed by speculations as to the causes of volcanic vents shifting their position. Whatever doubts the philosopher expresses as to the nature of these causes, it is assumed, as incontrovertible, that the points of eruption will hereafter vary, *because they have formerly done so.*

We have endeavoured to show, by former chapters, how utterly this principle of reasoning is set at nought by the modern schools of geology, which not only refuse to conclude that great revolutions in the earth's surface are now in progress, or

that they will take place *because* they have often been repeated in former ages, but assume the improbability of such a conclusion and throw the whole weight of proof on those by whom that doctrine is embraced.

In our view of igneous causes we shall consider, first, the volcano, and afterwards the earthquake ; for although both are probably the effects of the same subterranean process, they give rise to very different phenomena on the surface of the globe. Both are confined to certain regions, but the subterranean movements are least violent in the immediate proximity of volcanic vents, especially where the discharge of aëriform fluids and melted rock is made constantly from the same crater. We say that there are certain regions to which both the points of eruption, and the movements of great earthquakes are confined ; and we shall begin by tracing out the geographical boundaries of some of these, that the reader may be aware of the magnificent scale on which the agency of subterranean fire is now simultaneously developed. Over the whole of the vast tracts alluded to, active volcanic vents are distributed at intervals, and most commonly arranged in a linear direction. Throughout the intermediate spaces there is abundant evidence that the subterranean fire is at work continuously, for the ground is convulsed from time to time by earthquakes ; gaseous vapours, especially carbonic acid gas, are disengaged plentifully from the soil ; springs often issue at a very high temperature, and their waters are very commonly impregnated with the same mineral matters which are discharged by volcanos during eruptions.

Of these great regions, that of the Andes is one of the best defined. Respecting its southern extremity, we are still in need of more accurate information, some conceiving it to extend into Terra del Fuego and Patagonia\*. But if we begin with Chili, in the forty-sixth degree of south latitude, we find that, in proceeding from this point towards the north to the twenty-seventh degree, there is a line of volcanos so uninterrupted, that it is rare to find any intervening degree of latitude in which there is not an active vent. About twenty of these are now enumerated, but we may expect the number to augment greatly when the country

\* Hoff, vol. ii., p. 476.

has been more carefully examined, and throughout a longer period. How long an interval of rest entitles us to consider a volcano extinct, cannot yet be determined; but we know that, in Ischia, there intervened, between two consecutive eruptions, a pause of *seventeen centuries*; and a much longer period, perhaps, elapsed between the eruptions of Vesuvius before the earliest Greek colonies settled in Campania, and the renewal of its activity in the reign of Titus. It will be necessary, therefore, to wait for at least six times as many centuries as have elapsed since the discovery of America, before any one of the dormant craters of the Andes can be presumed to be entirely spent, unless there are some *geological* proofs of the last eruptions having belonged to a remote era. The Chilian volcanos rise up through granitic mountains. Villarica, one of the principal, continues burning without intermission, and is so high that it may be distinguished at the distance of one hundred and fifty miles. A year never passes in this province without some slight shocks of earthquakes; and about once in a century, or oftener, tremendous convulsions occur, by which, as we shall afterwards see, the land has been shaken from one extremity to the other, and continuous tracts, together with the bed of the Pacific, have been raised permanently from one to twenty feet and upwards above their former level. Hot springs are numerous in this district, as well as springs of naphtha and petroleum, and mineral waters of various kinds. If we pursue our course northwards, we find in Peru only one active volcano as yet known; but the province is so subject to earthquakes, that scarcely a week happens without a shock, and many of these have been so considerable as to create great changes of the surface. Proceeding farther north, we find in the middle of Quito, where the Andes attain their highest elevation, from the second degree of south, to the third degree of north latitude, Tunguragua, Cotopaxi, Antisana, and Pichinca, the three former of which throw out flames not unfrequently. From fissures on the side of Tunguragua, a deluge of mud (*moya*) descended in 1797, and filled valleys a thousand feet wide to the depth of six hundred feet, forming barriers whereby rivers were dammed up, and lakes occasioned. Earthquakes have, in the same province, caused great revolutions in the physical features of the surface. Farther north, there are three vol-

canos in the province of Pasto, and three others in that of Popayan. In the provinces of Guatemala and Nicaragua, which lie between the Isthmus of Panama and Mexico, there are no less than twenty-one active volcanos, all of them contained between the tenth and fifteenth degrees of north latitude. The great volcanic chain, after having pursued its course for several thousand miles from south to north, turns off in a side direction in Mexico, and is prolonged in a great plateau, between the eighteenth and twenty-second degrees of north latitude. This high table-land owes its present form to the circumstance of an ancient system of valleys, in a chain of primary mountains, having been filled up, to the depth of many thousand feet, with various volcanic products. Five active volcanos traverse Mexico from west to east—Tuxtla, Orizaba, Popocatepetl, Jorullo, and Colima. Jorullo, which is in the centre of the great plateau, is no less than forty leagues from the nearest ocean—an important circumstance, as showing that the proximity of the sea is not a necessary condition, although certainly a very general characteristic, of the position of active volcanos. The extraordinary eruption of this mountain, in 1759, will be described in the sequel. If the same parallel line which connects these five vents be prolonged, in a westerly direction, it cuts the volcanic group of islands, called the Isles of Revillagigedo. To the north of Mexico there are three, or according to some, five volcanos, in the peninsula of California, but of these we have at present no detailed account. We have before mentioned the violent earthquakes which, in 1812, convulsed the valley of the Mississippi at New Madrid, for the space of three hundred miles in length. As this happened exactly at the same time as the great earthquake of Carracas, it is probable that these two points are parts of one continuous volcanic region; for the whole circumference of the intervening Caribbean Sea must be considered as a theatre of earthquakes and volcanos. On the north lies the island of Jamaica, which, with a tract of the contiguous sea, has often experienced tremendous shocks; and these are frequent along a line extending from Jamaica to St. Domingo, and Porto Rico. On the south of the same basin the shores and mountains of Colombia are perpetually convulsed. On the west, is the volcanic chain of Guatemala and Mexico, before traced out; and on the east

the West Indian isles, where, in St. Vincent's and Guadaloupe, are active vents.

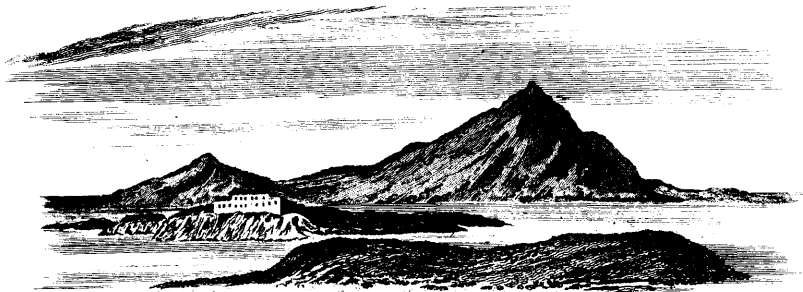
Thus it will be seen that volcanos and earthquakes occur uninterruptedly, from Chili to the north of Mexico; and it seems probable, that they will hereafter be found to extend from Cape Horn to California, or even perhaps to New Madrid, in the United States—a distance as great as from the pole to the equator. In regard to the eastern limits of the region, they lie deep beneath the waves of the Pacific, and must continue unknown to us. On the west they do not appear, except where they include the West Indian islands, to be prolonged to a great distance, for there seem to be no indications of volcanic disturbances in Guiana, Brazil, and Buenos Ayres.

On an equal, if not a still grander scale, is another continuous line of volcanic action, which commences, on the north, with the Aleutian Isles in Russian America, and extends, first in an easterly direction for nearly two hundred geographical miles, and then southwards, without interruption, throughout a space of between sixty and seventy degrees of latitude to the Moluccas, and there branches off in different directions both towards the east and north-west. The northern extremity of this volcanic region is the Peninsula of Alaska, in about the fifty-fifth degree of latitude. From thence the line is continued through the Aleutian or Fox Islands, to Kamtschatka. In that archipelago eruptions are frequent; and a new isle rose in 1814, which, according to some reports, is three thousand feet high and four miles round\*. Earthquakes of the most terrific description agitate and alter the bed of the sea and surface of the land throughout this tract. The line is continued in the southern extremity of the peninsula of Kamtschatka, where there are seven active volcanos, which, in some eruptions, have scattered ashes to immense distances. The Kurile chain of isles constitutes the prolongation of the range, where a train of volcanic mountains, nine of which are known to have been in eruption, trends in a southerly direction. In these, and in the bed of the adjoining sea, alterations of level have resulted from earthquakes since the middle of the last century. The line is then continued to the south-west in the great Island of Jesso, where

\* Hoff, vol. ii., p. 414.

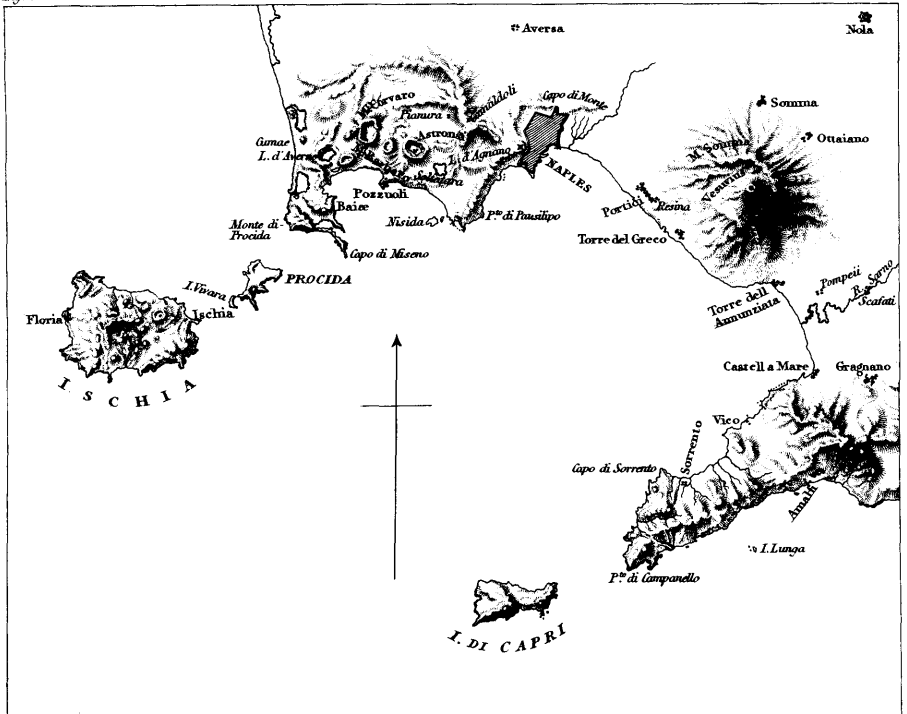
there are active volcanic vents, as also in Nipon, the principal of the Japanese group, where the number of burning mountains is very great; slight shocks of earthquakes being almost incessant, and violent ones experienced at distant intervals. Between the Japanese and Philippine Islands, the communication is preserved by several small insular vents. Sulphur Island, in the Loo Choo archipelago, emits sulphureous vapour; and Formosa suffers greatly from earthquakes. In Luzon, the most northern and largest of the Philippines, are three active volcanos; Mindinao also was in eruption in 1764. The line is then prolonged through Sanguir and the north-eastern extremity of Celebes, by Ternate and Tidore, to the Moluccas, and, amongst the rest, Sumbawa. Here a great transverse line may be said to run from east to west. On the west it passes through the whole of Java, where there are thirty-eight large volcanic mountains, many of which continually discharge smoke and sulphureous vapours. In the volcanos of Sumatra, the same linear arrangement is preserved; but the line inclines gradually to the north-west in such a manner as to point to the active volcano in Barren Island in the Bay of Bengal, in about the twelfth degree of north latitude. In another direction the volcanic range is prolonged through Borneo, Celebes, Banda, and New Guinea; and farther eastward in New Britain, New Ireland, and various parts of the Polynesian archipelago. The Pacific Ocean, indeed, seems, in equatorial latitudes, to be one vast theatre of igneous action; and its innumerable archipelagos, such as the New Hebrides, Friendly Islands, and Georgian Isles, are all composed either of coralline limestones, or volcanic rocks with active vents here and there interspersed. The abundant production of carbonate of lime, in solution, would alone raise a strong presumption of the volcanic constitution of these tracts, even if there were not more positive proofs of igneous agency.

If we now turn our attention to the principal region in the Old World, which, from time immemorial, has been agitated by earthquakes, and has given vent at certain points to subterranean fires, we find that it possesses the same general characters. This region extends from east to west for the distance of about one thousand geographical miles, from the Caspian Sea to the Azores; including within its limits the greater part



Island of Procida. = Island of Ischia.  
Part of the Coast of Misenum.

Fig. 2.







of the Mediterranean, and its most prominent peninsulas. From south to north, it reaches from about the thirty-fifth to the forty-fifth degree of latitude. Its northern boundaries are Caucasus, the Black Sea, the mountains of Thrace, Transylvania, and Hungary,—the Austrian, Tyrolian, and Swiss Alps,—the Cevennes and Pyrenees, with the mountains which branch off from the Pyrenees westward, to the north side of the Tagus. Its western limits are the ocean, but it is impossible to determine how far it may be prolonged in that direction; neither can we assign with precision its extreme eastern limit, since the country beyond the Caspian and Sea of Aral is scarcely known. The great steppe of Tartary, in particular, is unexplored; and we are almost equally ignorant of the physical constitution of China, in which country, however, many violent earthquakes have been felt.

The southern boundaries of the region include the most northern parts of Africa, and part of the Desert of Arabia\*. We may trace, through the whole area comprehended within these extensive limits, numerous points of volcanic eruptions, hot springs, gaseous emanations, and other signs of igneous agency; while few tracts, of any extent, have been entirely exempt from earthquakes throughout the last three thousand years.

To begin on the Asiatic side, we find that, on the western shores of the Caspian, in the country round Baku, there is a tract called the Field of Fire, which continually emits inflammable gas, and springs of naphtha and petroleum occur in the same vicinity, as also mud volcanos. In the chain of Elburs, to the south of this sea, is a lofty mountain, which, according to Morier, sometimes emits smoke, and at the base of which are several small craters, where sulphur and saltpetre are procured in sufficient abundance to be used in commerce. Violent subterranean commotions have been experienced along the borders of the Caspian; and it is reported that, since 1556, the waters of that sea have encroached on the Russian territory to the north; but the fact, as Malte-Brun observes, requires confirmation. According to Engelhard and Parrot, the depth of the water has increased in places, while the general surface has been lowered; and they say that the bottom of the sea has, in modern

\* Hoff, vol. ii., p. 99.

times, varied in form ; and that, near the south coast, the Isle of Idak, north from Astrabat, formerly high land, has now become very low\*. Any indications of a change in the relative levels of the land in this part of Asia are of more than ordinary interest, because a succession of similar variations would account for many prominent features in the physical geography of the district between the salt lake Aral, and the western shores of the Euxine—a district well known to have been always subject to great earthquakes. The level of the Caspian is lower than that of the Black Sea, by more than fifty feet. A low and level tract, called the Steppe, abounding in saline plants, and said to contain shells of species now common in the adjoining sea, skirts the shores of the Caspian, on the north-west. This plain often terminates abruptly by a line of inland cliffs, at the base of which runs a kind of beach, consisting of fragments of limestone and sand, cemented together into a conglomerate. Pallas has endeavoured to show that there is an old line of sandy country, which indicates the ancient bed of a strait, by which the Caspian Sea was once united to that of Azof. On similar grounds, it is inferred that the salt lake Aral was formerly connected with the Caspian. However modern in the earth's history the convulsions may be which have produced the phenomena of the steppes, it is consistent with analogy to suppose that a very minute portion of the whole change has happened in the last twenty or thirty centuries. Yet, if we possessed more authentic records of physical events, we should probably discover that some small portion of those great revolutions have fallen within such recent periods. Remote traditions have come down to us of inundations, in which the waters of the Black Sea were forced through the Thracian Bosphorus, and through the Hellespont, into the *Ægean*. In the deluge of Samothrace, it appears that that small island, and the adjoining coast of Asia, were inundated ; and in the Ogygian, which happened at a different time, *Bœotia* and *Attica* were overflowed. Notwithstanding the mixture of fable, and the love of the marvellous, in those rude ages, and the subsequent inventions of Greek poets and historians,

\* Travels in the Crimea and Caucasus, in 1815, vol. i., pp. 257 and 264.—Hoff, vol. i., p. 137.

it may be distinctly perceived that the floods alluded to were local and transient, and that they happened in succession near the borders of that chain of inland seas. They seem, therefore, to have been nothing more than great waves, which, about fifteen centuries before our era, devastated the borders of the Black Sea, the Sea of Marmora, the Archipelago and neighbouring coasts, in the same manner as the western shores of Portugal, Spain, and Northern Africa were inundated, during the great earthquake at Lisbon, by a wave which rose, in some places, to the height of fifty or sixty feet; or as happened in Peru, in 1746, where two hundred violent shocks followed each other in the space of twenty-four hours, and the ocean broke with impetuous force upon the land, destroying the town of Callao, and four other seaports, and converting a considerable tract of inhabited country into a bay.

In the country between the Caspian and the Black Seas, and in the chain of Caucasus, numerous earthquakes have, in modern times, caused fissures and subsidences of the soil, especially at Tiflis\*. The Caucasian territories abound in hot-springs and mineral waters. So late as 1814, a new island was raised by volcanic explosions, in the Sea of Azof; and Pallas mentions that, in the same locality, opposite old Temruk, a submarine eruption took place in 1799, accompanied with dreadful thundering, emission of fire and smoke, and the throwing up of mire and stones. Violent earthquakes were felt at the same time at great distances from Temruk. The country around Erzerum exhibits similar phenomena, as does that around Tauris and the lake of Urmia, in which latter we have already remarked the rapid formation of travertin. The lake of Urmia, which is about two hundred and eighty English miles in circumference, resembles the Dead Sea, in having no outlet, and in being more salt than the ocean. Between the Tigris and Euphrates, also, there are numerous springs of naphtha, and frequent earthquakes agitate the country.

Syria and Palestine abound in volcanic appearances, and very extensive areas have been shaken, at different periods, with great destruction of cities and loss of lives.

It has been remarked, by Von Hoff, that from the commencement of the thirteenth to the latter half of the seventeenth century, there was an almost entire cessation of earthquakes

\* Hoff, vol. ii., p. 210.

in Syria and Judea ; and, during this interval of quiescence, the Archipelago, together with part of the adjacent coast of Lesser Asia, as also Southern Italy and Sicily, suffered extraordinary convulsions ; while volcanic eruptions in those parts were unusually frequent. A more extended comparison, also, of the history of the subterranean convulsions of these tracts seems to confirm the opinion, that a violent crisis of commotion never visits both at the same time. It is impossible for us to declare, as yet, whether this phenomenon is constant in this, or general in other regions, because we can rarely trace back a connected series of events farther than a few centuries ; but it is well known that, where numerous vents are clustered together within a small area, as in many archipelagos for instance, two of them are never in violent eruption at once. If the action of one becomes very great for a century or more, the others assume the appearance of spent volcanos. It is, therefore, not improbable that separate provinces of the same range of volcanic fires may hold a relation to one deep-seated focus, analogous to that which the apertures of a small group bear to some one rent or cavity. Thus, for example, we may conjecture that, at a comparatively small distance from the surface, Ischia and Vesuvius mutually communicate with certain fissures, and that each afford relief alternately to elastic fluids and lava there generated. So we may suppose Southern Italy and Syria to be connected, at a much greater depth, with a lower part of the very same system of fissures ; in which case any obstruction occurring in one duct may have the effect of causing almost all the vapour and melted matter to be forced up the other, and if they cannot get vent, they may be the cause of violent earthquakes.

Continual mention is made in history of the ravages committed by earthquakes in Sidon, Tyre, Berytus, Laodicea, and Antioch, as also in the island of Cyprus. The country around the Dead Sea appears evidently, from the accounts of modern travellers, to be volcanic ; and there are similar appearances, according to Burckhardt, in Arabia Petrea. A district near Smyrna, in Asia Minor, was termed by the Greeks *Catacecaumene*, or the burnt, where there is a large arid territory, without trees, and with a cindery soil\*.

Proceeding westwards, we reach the Grecian archipelago,

\* Strabo, Ed. Fal., p. 900.

where Santorin, afterwards to be described, is the grand centre of volcanic action. To the north-west of Santorin is another volcano, in the island of Milo, of recent aspect, having a very active solfatara in its central crater, and many sources of boiling water and steam. Continuing precisely the same line, we arrive at that part of the Morea, where we learn, from ancient writers, that Helice and Bura were, in the year 373 B. C., submerged beneath the sea by an earthquake; and the walls, according to Ovid, were to be seen beneath the waters. Near the same spot, in our times (1817), Vostizza was laid in ruins by a subterranean convulsion\*. At Methone, also (now Modon), in Messenia, about three centuries before our era, an eruption threw up a great volcanic mountain, which is represented by Strabo as being nearly four thousand feet in height; but the magnitude of the hill requires confirmation. Some suppose that the accounts of the formation of a hill near Træzene, of which the date is unknown, may refer to the same event. Macedonia, Thrace, and Epirus, have always been subject to earthquakes, and the Ionian Isles are continually convulsed. Respecting Southern Italy, Sicily, and the Lipari Isles, we need not enlarge here, as the existence of volcanos in that region is known to all, and we shall have occasion again to allude to them.

The north-eastern portion of Africa, including Egypt, which lies six or seven degrees south of the volcanic line already traced, has been almost always exempt from earthquakes; but the north-western portion, especially Fez and Morocco, which fall within the line, suffer greatly from time to time. The southern part of Spain, also, and Portugal, have generally been exposed to the same scourge simultaneously with Northern Africa. The provinces of Malaga, Murcia, and Grenada, and in Portugal, the country round Lisbon, are recorded at several periods to have been devastated by great earthquakes. It will be seen, from Michell's account of the great Lisbon shock in 1755, that the first movement proceeded from the bed of the ocean ten or fifteen leagues from the coast. So late as February 2, 1816, when Lisbon was vehemently shaken, two ships felt a shock in the ocean west from Lisbon; one of them at the distance of one hundred and twenty, and the other two hundred and sixty-two French leagues from the

\* Hoff, vol. ii., p. 172.

coast\*—a fact which is the more interesting, because a line drawn through the Grecian archipelago, the volcanic region of Southern Italy, Sicily, Southern Spain, and Portugal, will, if prolonged westward through the ocean, strike the volcanic group of the Azores, which has, therefore, in all probability, a submarine connexion with the European line. How far the isles of Madeira and the Canaries, in the former of which violent earthquakes, and in the latter great eruptions, frequently happen, may communicate beneath the waters with the same region, must for the present be mere matter of conjecture.

Besides the continuous spaces of subterranean disturbance of which we have merely sketched the outline, there are other disconnected volcanic groups, of which the geographical extent is as yet very imperfectly known. Among these may be mentioned Iceland, which belongs, perhaps, to the same region as the volcano in Jan Mayen's Island, situated five degrees to the north-east. With these, also, part of the nearest coast of Greenland, which is sometimes shaken by earthquakes, may be connected. The island of Bourbon belongs to another theatre of volcanic action, of which Madagascar probably forms a part, if the alleged existence of burning volcanos in that island shall, on further examination, be substantiated. In following round the borders of the ocean to the north, we find the volcano of Gabel Tor, within the entrance of the Arabian Gulf. In the province of Cutch, in Bombay, and the adjoining districts of Hindostan, violent earthquakes repeatedly devastate an extensive territory.

Respecting the volcanic system of Southern Europe, it may be observed, that there is a central tract where the greatest earthquakes prevail, in which rocks are shattered, mountains rent, the surface elevated or depressed, and cities laid in ruins. On each side of this line of greatest commotion, there are parallel bands of country, where the shocks are less violent. At a still greater distance (as in Northern Italy, for example, extending to the foot of the Alps), there are spaces where the shocks are much rarer and more feeble, yet possibly of sufficient force to cause, by continued repetition, some appreciable alteration in the external form of the earth's crust. Beyond these limits, again, all countries are liable to slight tremors at distant intervals of time, when some great crisis of subterranean movement agitates an adjoining volcanic region; but these may be consi-

\* Verneur, *Journal des Voyages*, vol. iv., p. 111. Hoff, vol. ii., p. 275.

dered as mere vibrations, propagated mechanically through the external crust of the globe, as sounds travel almost to indefinite distances through the air. Shocks of this kind have been felt in England, Scotland, Northern France, and Germany—particularly during the Lisbon earthquake. But these countries cannot, on this account, be supposed to constitute parts of the southern volcanic region, any more than the Shetland and Orkney Isles can be considered as belonging to the Icelandic circle, because the sands ejected from Hecla have been wafted thither by the winds.

We must also be careful to distinguish between lines of extinct and active volcanos, even where they appear to run in the same direction; for ancient and modern systems may cross and interfere with each other. Already, indeed, we have proof that this is the case; so that it is not by geographical position, but by reference to the species of organic beings alone, whether aquatic or terrestrial, whose remains occur in beds interstratified with lavas, that we can clearly distinguish the relative age of volcanos of which no eruptions are recorded. Had Southern Italy been known to civilized nations for as short a period as America, we should have had no record of eruptions in Ischia; yet we might have assured ourselves that the lavas of that isle had flowed since the Mediterranean was inhabited by the species of testacea now living in the Neapolitan seas. With this assurance it would not have been rash to include the numerous vents of that isle in the modern volcanic group of Campania. On similar grounds we may class, without much hesitation, the submarine lavas of the Val di Noto in Sicily, in the modern circle of subterranean commotion, of which Etna and Calabria form a part. But the lavas of the Euganean hills and the Vicentin, although not wholly beyond the range of earthquakes in Northern Italy, must not be confounded with any existing volcanic system; for when they flowed, the seas were inhabited with animals entirely distinct from those now known to live, whether in the Mediterranean or other parts of the globe. But we cannot enter into a full development of our views on these subjects in the present volume, as they would carry us into the consideration of changes in the earth's surface far anterior to the times of history, to which our present examination is exclusively confined.